solplan review

the independent newsletter of energy efficient building practice

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INSIDE

As we improve the way we build houses, we learn that we have to pay attention to how a house performs. It is no longer good enough to assume that if it was built as in the past, it will work today.

In the past houses were ventilated and kept safe for the occupants by mere fact that they were built quite leaky. Modern draft-free construction practices require that we carefully examine the interactions happen in a house.

This month we review how natural infiltration ventilates a house and influences indoor air pressures. It also influences fuel fired appliances, such as furnaces, hot water tanks, fireplaces and stoves. Recent studies have shown that too often these spill combustion gasses back into the house, creating unhealthy conditions.

We review a study of potential remedial action for attic moisture. Attic condensation is a major problem in the North. The problems contain a lesson for those who build in the south as well - it gives an idea of what can happen if we don't build properly.

Also this month we present the latest efficiency ratings of heat recovery ventilators. Other items include a review of the causes of truss uplift and how to avoid problems, news about the new CHBA-BC Housing Industry Training Centre, and a commentary on the proposed Canada-USA free trade agreement.

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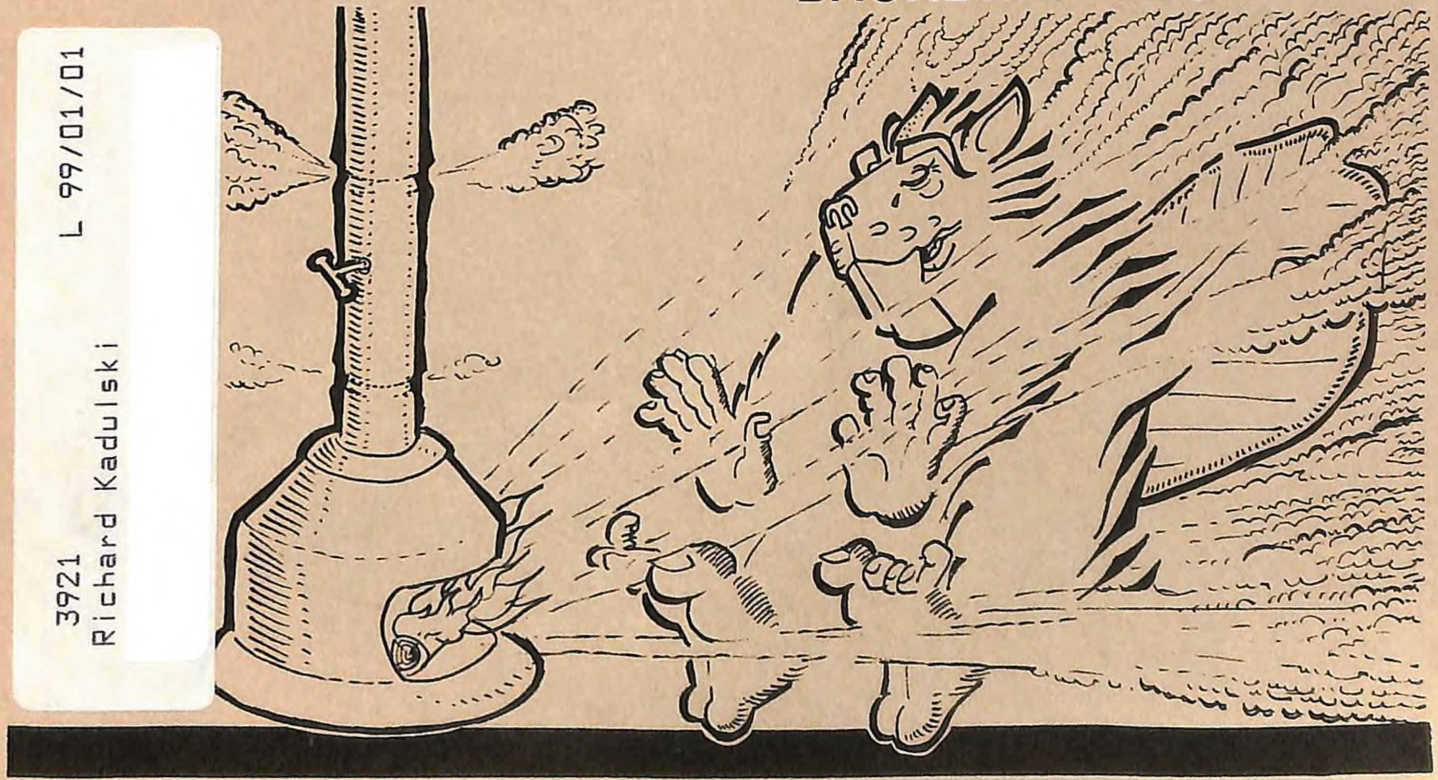

FROM THE PUBLISHER

Building Codes are the main regulatory means that influence and impact on the housing industry. When changes are introduced, industry is often the first to complain about excessive regulations and unwarranted government intrusion in the marketplace.

But not all regulations are unwarranted. They are put into place because of the need to ensure minimum performance and materials standards for health and safety. Most regulations have been introduced to meet real or perceived needs to protect the public. Some regulations may be excessive and for that the industry has only itself to blame.

The process by which codes and standards are written is long and slow, involving many players. Anyone has an opportunity to comment and propose changes. However, builders are slow to get involved with code writing.

Ventilation requirements have been introduced in the new 1985 Code, but without proper standards in place to define what will satisfy the desired objectives. If the industry had paid heed, they could have provided input on how to introduce the needed changes to ensure adequate ventilation is provided.

The 1990 Code is now being finalized. Proposals are being made that residential sprinklers be mandatory, regardless of dwelling type, size or cost. This is only one proposed change among many. There may be a valid reason for such changes. But they must be assessed by all concerned - builders must act now, not just react after the fact!

Richard Kadulski
Publisher

NATIONAL BUILDING CODE (1990 EDITION) DEADLINE FOR PROPOSED CHANGES

The 1990 edition of the National Building Code of Canada is now being reviewed. Proposals for changes must be received at the National Research Council by December 31, 1987. Code change requests in by this date are guaranteed consideration by the Code committees for possible inclusion in the 1990 edition of the NBC.

Write:

Associate Committee on the NBC
National Research Council of Canada
Ottawa, Ont. K1A 0R6

NEW DHW heater

The price of high efficiency domestic water heaters should start to drop with increased competition. Until recently, there has only been 2 gas fired models available in Canada: the **State Turbo** sealed combustion and the **Rheem** induced draft.

A new unit manufactured by Bradford-White Water Heaters Inc. is currently undergoing testing by the Canadian Gas Association.

The unit as designed may be located up to 6 feet from an outside wall and (where local authorities permit) can be installed with a flexible EPDM tubing vent.

It has been in use in the USA (where it is manufactured) for 2 years now.

At a suggested wholesale price in the $500 range, it reduces the price differential between the high efficiency units and conventional domestic hot water heaters.

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VENTILATION AND AIR PRESSURE IN HOUSES

Adequate ventilation is essential to ensure proper indoor air quality, control condensation, and in some cases ensure an adequate supply of combustion air for fuel-fired heated appliances. In the past ventilation was supplied by air leakage through cracks and openings in the building envelope.

Current construction practices and the upgrading of existing stock has led to tighter building envelopes. This is so successful that air leakage cannot be relied upon as the prime source of ventilation air. As a result, mechanical ventilation systems are now required by the National Building Code to meet necessary ventilation.

Ventilation System Types

There are three basic types of mechanical ventilation system:

A balanced system draws outdoor air into the house and expels an equal amount of indoor air outdoors. A balanced system does not need a heat recovery ventilation. The HRV is only used to save energy by heating the required ventilation air with heat recovered from the exhaust air.

A supply-only system relies on a fan to bring outdoor air into a house, pressurizing the house and increasing the outward flow through cracks and openings in the building envelope.

An exhaust-only system works in the opposite way. It uses an exhaust fan to draw indoor air out, thus putting the house under negative pressure drawing outdoor air in through cracks and openings in the building envelope.

Choosing a Ventilation Strategy

Houses with a supply-only system are more likely to have condensation problems than houses with either of the other systems. Moisture can condense in the structure and be absorbed by the building materials at the lower temperatures encountered outside the vapour barrier. For this reason a supply-only system is not recommended in heating climates.

The choice is essentially between balanced and an exhaust-only systems. A balanced system is suited to houses with fireplaces or fuel-fired heating appliances, or where radon gas or other contaminants may collect in the building structure.

Interaction between Ventilation System and House

Ventilation air includes outdoor air supplied by mechanical ventilation, air coming in through open windows and doors, and air infiltration through cracks and openings in the building envelope. All are weather dependent components.

The tighter the house, the smaller the influence of this uncontrolled ventilation.

On a two story house with a balanced system total ventilation increases as the outdoor air temperature drops.

For a similar house with an exhaust-only system the ventilation supply rate is relatively insensitive to both wind and temperature difference and remains essentially constant.

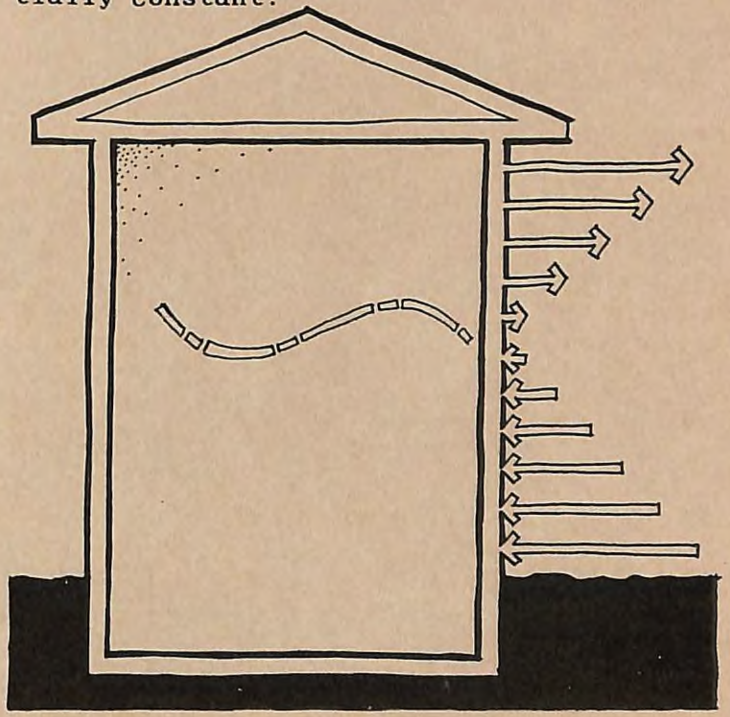


fig. a

Without mechanical ventilation *(fig.a)*, the outdoor air pressure is greater than the indoors at the lower levels; the reverse is true at the upper levels. Roughly at mid height interior and exterior pressures are equal. This point is called the ***neutral pressure plane***. This plane is not always a flat plane - it should be thought of as a scarf blowing in the wind, as it depends on wind strength, direction, and temperature difference between inside and outside the house. Below it air infiltration occurs; above it air exfiltration. In a typical 2 story house this could easily be .25 ach.

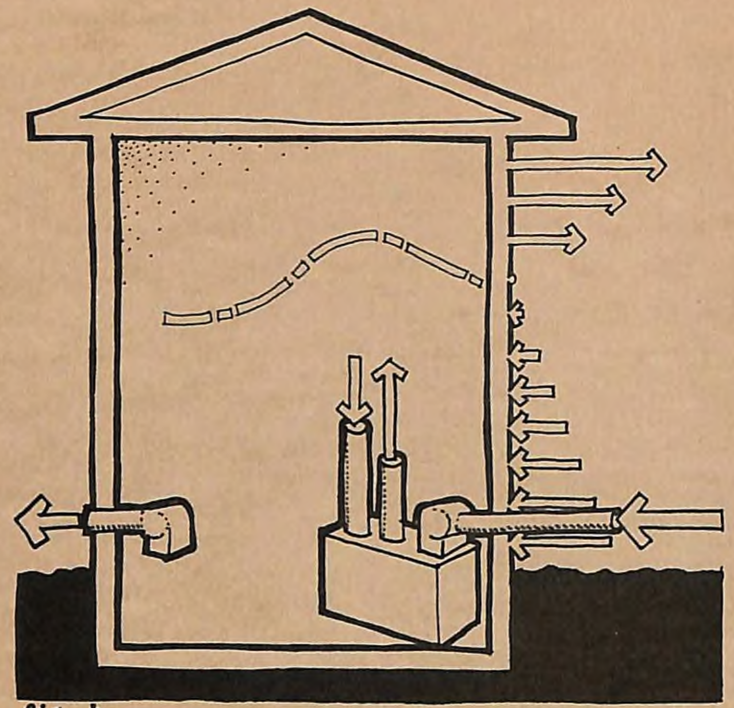


fig. b

In a study of a house with a balanced system providing air at a rate of 0.5 ac/h *(fig.b)*, the ventilation rate was actually determined to be about 0.7 ac/h. The system was, in fact, unbalanced. Why? the cold outdoor air when it entered the warm house expanded so that the supply air rate exceeded the exhaust air rate by 10 cfm. As a result, the air pressure inside increased slightly, causing a decrease in the air infiltration rate.

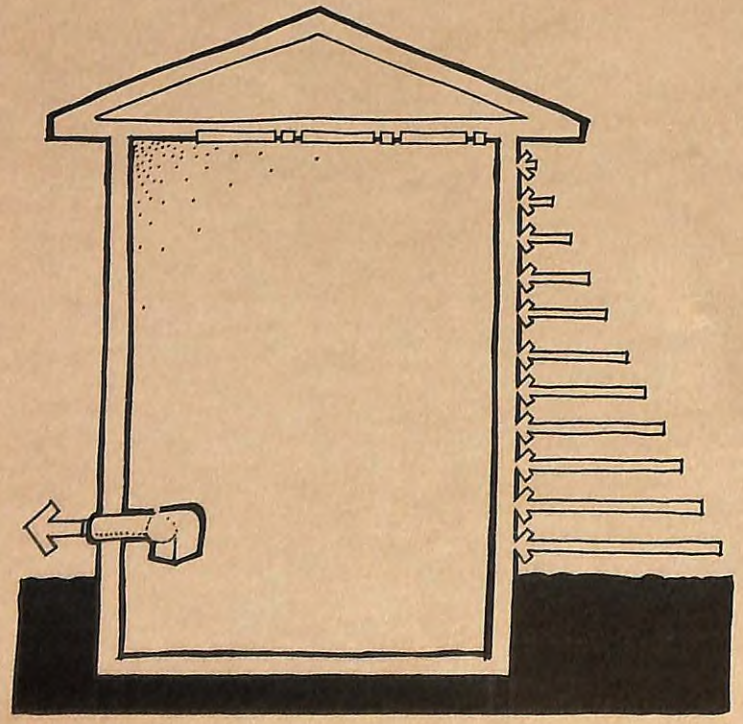


fig. c

With an exhaust-only system of 0.5 ac/h *(fig.c)*, the ventilation rate can equal the exhaust air rate, pushing the neutral pressure plane to the ceiling level of the top floor so there is no air exfiltration through the envelope.

As with exhaust fans, chimney stack action can move the neutral pressure level upwards increasing the ventilation rate from 0.25 to 0.3 ac/h. *(fig.d)* If a balanced system were installed, the ventilation rate would increase but the house pressure and thus the venting capacity of the chimney would not be affected significantly.

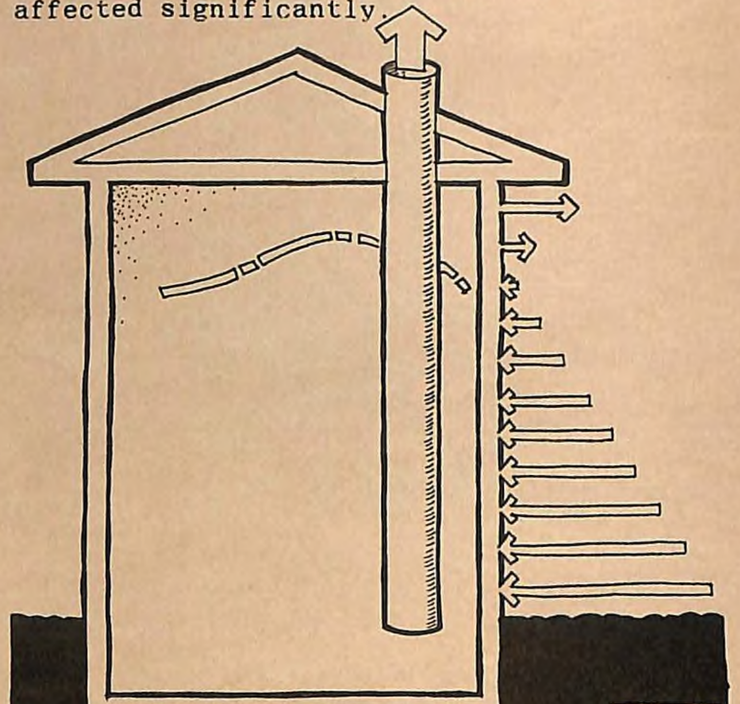


fig. d

In an exhaust-only system, the neutral pressure plane would move up, reducing the house pressure and the venting capacity of the chimney. (If the neutral pressure plane, were to move above the ceiling level of the top storey, combustion gas spillage and/or chimney backdrafting could occur.)

Sizing of Mechanical Ventilation Systems

In practice, uncontrolled air infiltration is not considered in sizing ventilation systems because it is difficult to estimate. However the amount of ventilation received by a house by the combination of mechanical venting and uncontrolled infiltration often exceeds the design ventilation rate.

In winter this can be wasteful. For a house with a 0.5 ac/h balanced system and an infiltration rate of 0.25 ac/h, the amount of ventilation air received can exceed the air flow the mechanical ventilation system by as much as 40 percent. The mean air infiltration rate for the winter months is proportional to the air tightness of the house and can best be determined by a fan pressurization test.

These effects are one source of homeowner complaints about too much ventilation in mechanically vented houses.

To satisfy ventilation requirements a mechanical ventilation system should be capable of delivering the design air flows. However, to provide comfort and conserve energy in winter it should be equipped with a flow controller such as a two-speed fan and operate under reduced flow to take advantage of the increased natural air infiltration. A manual switch or an indoor humidistat should be used.

When microprocessor controlled ventilation systems are commonly available, this problem will not exist as the ventilation system controls will be capable of handling all pressure imbalances.

Air Distribution

Although there may be an adequate supply of ventilation air for the house as a whole, it may not be adequate as all rooms may not benefit from it. It is important to keep in mind that distribution of air is important.

With forced-air heating systems the most effective and economical way of distributing ventilation air is to use the existing air ducts, using the furnace fan to distribute the air (using a 2 speed fan makes the most effective use of the equipment).

FLUE BACKDRAFTING

Research has shown that combustion appliances (furnaces, hot water tanks, fireplaces, stoves) do not always properly exhaust products of combustion, and that this is becoming a problem in Canadian housing.

Backdrafting of flues contributes to poor indoor air quality. However, all the health and safety hazards due to combustion venting problems in houses have not been well documented or investigated.

Why be concerned about backdrafting?

One in 3 houses experiences some form of backdrafting. Combustion-derived indoor air pollutants released in homes during chimney failure include: carbon monoxide, carbon dioxide, sulphur dioxide, aldehydes, and particulates. The pollutants of main concern for health include carbon monoxide, sulphur dioxide, nitrogen oxide, aldehydes, and certain hydrocarbons.

What are the main pollutants?

Concentrations of carbon dioxide often reach levels in the range of 3000-5000 ppm (Heath and Welfare Canada suggests the acceptable maximum level should be 3500ppm). Such concentrations of CO_2 do not indicate a major health hazard, although it is possible that in 10 or 20% of houses concentrations could reach 10,000-15,000 ppm after several hours of continued backdrafting. This suggests that in some houses other pollutants may also appear in high concentrations. Generally, the CO_2 concentrations do not appear to represent a significant health hazards over the short term.

High concentrations of CO during venting failures are the result of other problems with the furnace system such as dirty burners or cracked heat exchangers. CO is not a directly related by-product. However, if those incidents are increasing, there will be an absolute increase in cases where CO is a factor. Since the number of venting failures already seems to be significant and seems to be increasing, an argument can be made for the increased use of warning devices and improved maintenance procedures for furnaces and water heaters. CO sensors, in particular, may be advisable in houses with appliances that are prone to more frequent spillage occurrence or higher pollutant concentrations. High risk houses would include those with hydronic heating systems and those with conversion burners.

On the other hand, fireplaces almost always represent a CO hazard as spillage from fireplaces is common.

Nitrogen dioxide is a toxic gas. Test results indicate that poorly tuned furnaces, can spill enough NO_2 gas to raise concentrations above safe levels. Its distribution parallels that of CO_2. This pollutant could have a major impact on the health of occupants.

How bad is the problem?

A major CMHC study of more than 1000 houses across Canada has shown that a small but significant portion of Canadian houses experience more than "normal" combustion spillage or backdrafting.

The objectives of the study were to identify houses that are experiencing significant spillage of combustion gases and to determine how often the backdrafting problems occur.

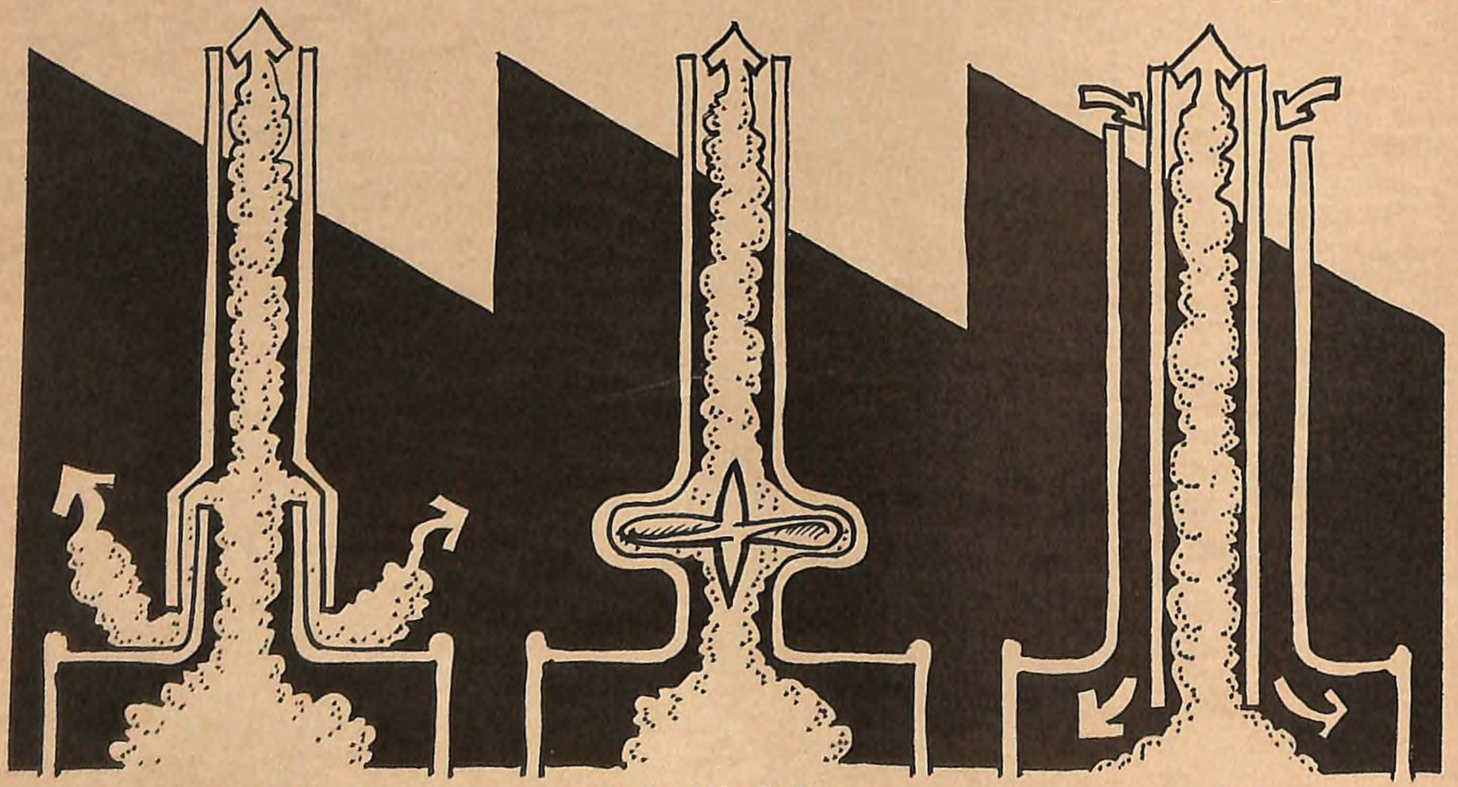
There are many causes for the spillage. These include poorly installed or maintained equipment and high levels of house depressurization caused by exhaust equipment. Health hazards caused by spillage of combustion gases are not normally serious but are most likely to occur in cases involving wood burning or malfunctioning oil or gas burning appliances. However, pollutant concentrations were found to be high enough to cause concern about long-term health hazards. More research on this issue has been suggested.

Canadian housing is becoming more prone to combustion venting failures that could result in health and/or life threatening hazards. This trend is developing due to a number of factors:

1. Recent widespread conversion from oil heating to gas heating, often without proper safeguards such as the installation of chimney liners. More backdrafting occurs in houses with exterior chimneys and with masonry chimneys with improperly sized metal liners. Although lining a chimney should generally improve draft and reduced spillage potential, the effect of a new liner is to reduce the chimney's flow capacity. Thus the liner can contribute to spillage unless the firing rates of the appliances served by the chimney are reduced to match the reduced flue size.
2. Decrease in the frequency and effectiveness of furnace servicing. A high proportion of backdrafting occurred in those houses where the last service call was more than one year previous.
3. Construction practices that produce tighter new houses and air sealing of existing houses for energy conservation.
4. Increased use of powerful exhaust equipment such as range-top barbecues. Houses with high exhaust capacity (those with 3 or more exhaust fans) encounter more spillage due to house depressurization (A Jenn Air cooktop was said to produce a depressurization of 6-7 pa).

In 75% of the houses investigated, house depressurization was identified as one cause of spillage. In 40% of the houses it appeared to be the only cause.

The age of the house also had some bearing on how much backdrafting there was.



naturally aspirating flue *induced draft flue* *sealed combustion*

The oldest and the newest houses surveyed had above average number of backdrafting occurrences. It appears that increased problems in older houses (pre-1945) may become more frequent. This may be due to chimney deterioration, liners, leaks, poor maintenance and fuel conversions.

Backdrafting problems in newer (post-1975) houses maybe caused by house depressurization as new houses are much tighter and more likely to have exhaust fans.

The geometry of the house profile has some bearing on how much backdrafting happens. One and one-and-a-half storey houses, compared with two and two-and-a-half storey houses have more backdrafting problems.

Flue Pressures: How Much is Needed to Create a draft?

The R2000 program has set limits of acceptable pressure imbalance in the house. While they may be somewhat arbitrary numbers, they do have so theoretical basis.

The minimum driving pressure for all flues is 3 Pascals. As well, an additional 1 Pascal is required for wind effects, 1 Pascal for additional chimney height, 1 Pascal for heavy furnaces or boilers, and another 1 Pascal for the additional input from a second appliance sharing the same flue. Thus it takes a minimum of 5 pascals to create a draft. Stated another way, a house depressurized by 5 Pascals will have difficulty starting a draft.

Remedial actions: What to do about the problem?

Obviously if the chimney is partially or totally blocked the problem is relatively simple to identify and correct. However, often a chimney will not work properly due to pressure induced failure, as will happen when the house is depressurized. When the house is under negative pressure, greater than required by the flue, combustion gasses can spill backwards into the house.

A common approach to avoid problems suggests that makeup air be introduced into the house. This is done to avoid conditions of negative pressure in the house. (It is something that the R-2000 Program stresses now).

Tests conducted on an older house in Saskatoon showed that it is not enough just to place a supply duct into a house to avoid pressure induced spillage of combustion products if it is brought **unaided** through an opening in the envelope even if it is correctly sized.

Tests on remedial air supply, consisting of a simply ducting outside air in (without a fan) to the vicinity of the exhaust appliance, have found it to be unsatisfactory. The changes in depressurization produced by this type of air supply are trivial.

It will be effective if a fan is used and if that fan has a capacity equal to the total capacity of all exhaust equipment in the house it is trying to overcome. This additional supply air will create few thermal comfort problems if introduced in a normally unoccupied area such as the furnace room.

Only if interior doors are open and the furnace circulation fan is not operating, will any pressurizing or depressurizing effect of an exhaust or supply fan or supply air opening be felt uniformly throughout the house instantaneously.

As well it was found that two fans display interactional effects when operating simultaneously. Their combined performance will not be predicted by a simple addition of their individual performances.

Controlling Pollutants at Source

The rate of pollutant emission varies with how the appliance is operated. These factors include:

1. A yellow flame on a gas appliance generally increases carbon monoxide and nitrogen dioxide concentration, while reducing the total NO_2 concentration.
2. Inadequate air supply to the burner of a gas-fired appliance may reduce the nitrogen dioxide emissions but will greatly increase carbon monoxide emission.
3. Excess air supply to the burner of a gas-fired appliance usually has little effect on emission rates of CO or NO_2.
4. The temperature of the heat exchanger of a gas-fired furnace is unlikely to affect emission rates significantly.
5. Low burn rates in a wood stove or fireplace are likely to increase the production of carbon monoxide, hydrocarbons, and polycyclic organic materials .
6. Emissions from oil burners during the 10 to 30 second start-up period (when spillage is most frequent) may contain increased

particle and CO concentrations and may need to be analyzed separately from the post start-up emissions.

7. Gas furnace CO emission rates in the first several minutes following start-up are up to ten times the steady state rates.

Gas Conversions

Conversions from oil to gas increase the potential for combustion gas spillage, mainly due to improper chimney operation because:

- The length of flue connectors is changed.
- There is a reduced chimney height due to a taller appliance
- Leakier flue pipes with flimsier connections
- Flue constrictions, often as a result of flexible flue liners
- Increased obstacles, most notably rain and wind caps on chimney tops
- Lower flue gas temperature
- More holes and gaps where the new flue pipe connects with the vertical chimney or with other flue pipes.

Fireplaces

A detailed study was done on fireplace flues in Canadian houses. The monitoring was done over a 90 day period for each house. The sample included 12 open masonry fireplaces and 12 fireplaces with conventional glass doors, all chosen at random.

Since most people operate fireplaces with the glass doors open, the presence of doors does not make a difference in the performance.

Flue performance was studied. Analysis also considered house characteristics, airtightness levels and maximum depressurization created by exhaust appliances in the house. It was found that seven (of 24) houses had venting problems involving combustion appliances other than the fireplace. A common problem was excessive spillage from furnace or water heater chimneys under worst case conditions. Five (20%) of these houses also exceeded the house depressurization limits established for safe chimney operation.

Spillage of combustion gases is common for conventional fireplaces. In most cases the amount was surprisingly high.

Carbon monoxide spillage is less than for smoke spillage. However, when there was CO spillage, the duration of each incident was much longer than for smoke, (an average CO spill lasted 2.7 minutes). Overall, fireplaces tested spilled combustion gasses for 2.5% of their operating time.

One house with consistently long spillage periods had heavy staining above the open fireplace. This suggests a tendency to regular long spillage. The homeowners had indicated that wood smoke odours are common.

The owners in another house noticed frequent clicking of the counters (on the monitoring equipment) when "logs rolled to front of the firebox" or "when the damper was closed too soon."

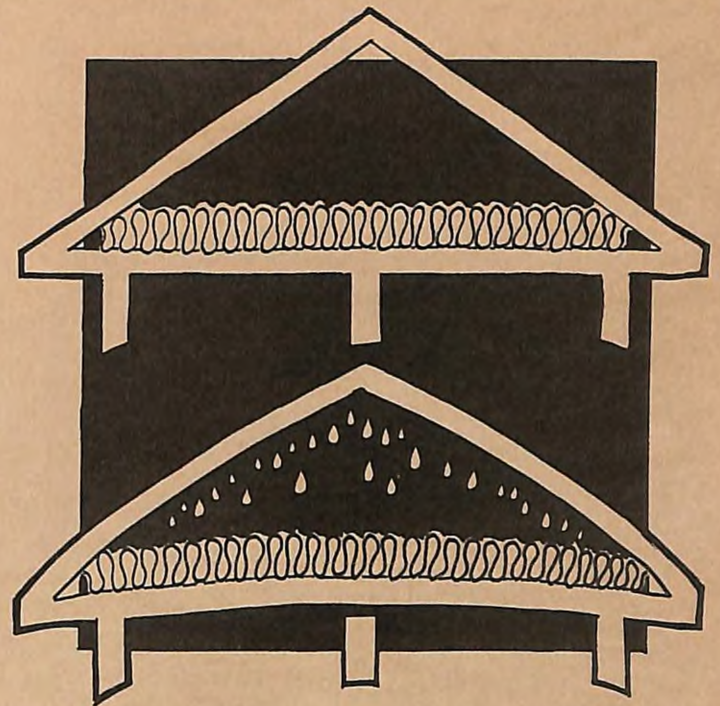
The large number of short-term smoke backdraft incidents raises the chance that large quantities of combustion products are entering houses through wood burning fireplaces. It is usually gradual allowing for the mixing and dilution of gases with the total volume of household air, avoiding concentrations of smoke sufficient to alert or annoy occupants.

No single fireplace or house feature was identified with a tendency towards spillage. However, it is suspected that chimney design and fireplace operation are the key variables.

The study authors suggest that in view of the lack of evidence of significant safety hazards it is NOT recommended that major efforts to alert the general public be made just yet. In other words, because there aren't any deaths or serious illness that can be attributed to malfunctioning equipment, the public shouldn't be stirred up. However, every builder and designer should recognize the warning signs. Backdrafting is far to common.

Residential combustion venting failure: a system approach. *Prepared by Scanada Sheltair Consortium for Canada Mortgage and Housing Corp.*
Summary Report plus 9 detail reports:
* *Canada wide survey results*
* *Modifications and refinements to the flue simulator model.*
* *Refinements to the chimney safety test: determining house depressurization limits*
* *Assessing the impact of combustion gas spillage on indoor air quality.*
* *Remedial measures for wood-burning fireplaces: airtight doors with direct air supply*
* *Makeup air supply remedial measures*
* *Remedial measures for gas-fired appliances*
* *Case studies of house with combustion gas spillage problems*
* *Communications strategy.*

TRUSS UPLIFT



Wood shrinks when it dries and swells when it becomes wet. The dimensional changes vary with the species and the orientation of the wood fibers. Every carpenter understands this, and takes this into account when framing a building.

The moisture level of the wood will eventually reach equilibrium with that of the surrounding air. This equilibrium moisture level mainly depends on the relative humidity of the air. Air temperature has little effect on the equilibrium moisture level over its normal indoor range.

Truss Uplift

A common effect of wood shrinkage that has become evident recently is the upward bowing of wood trusses in winter. This can cause cracks between partitions and the ceiling (in severe cases up to 20mm). Wood truss uplift is primarily caused by the differential longitudinal movement of the upper and lower chord member.

Air in a well-ventilated attic spaces contains about the same amount of moisture as the outside air. In winter the relative humidity of the outside air is fairly high. As a result the top chords and web members will absorb moisture until equilibrium is reached with the surrounding air. The higher moisture content causes the top chords to lengthen.

The lower chords, however, are often covered with up 12 or more inches of insulation and the average temperature in winter is close to the indoor temperature. The space in the insulation next to the wood has a much lower relative humidity than the air space adjacent to the top chord. As a result the air space next to the bottom chords absorbs moisture from the wood until an equilibrium moisture level is reached. The moisture content in the lower chords may be less than 10% during the coldest winter months, thus causing the bottom chords to shorten.

As the lower chords shrink and the top chords expand, the peak of the truss is forced up. This forces web members attached near the peaks to pull the lower chords upward, which in turn pulls up the ceiling causing cracks between the ceiling and patitions. If the chords contain compression or juvenile wood, the amount of movement will be significantly increased.

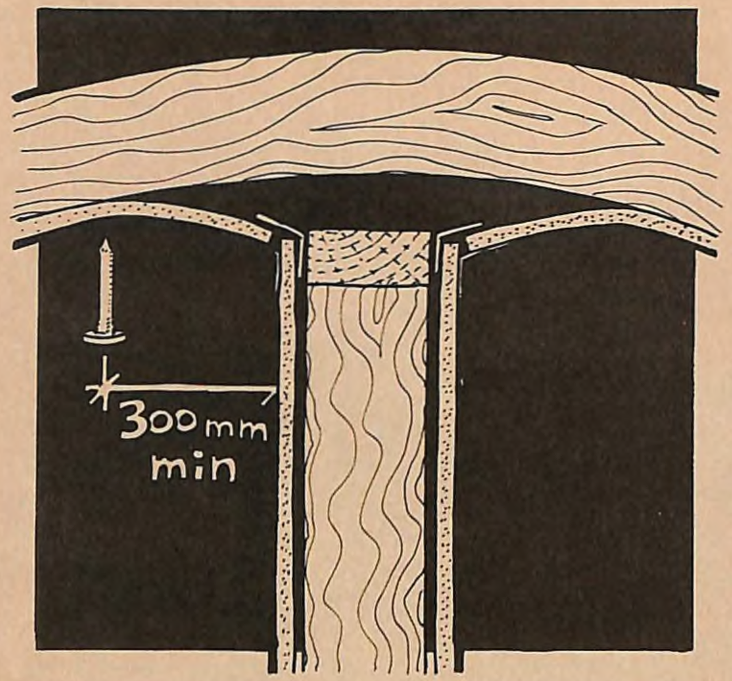
Use of unseasoned lumber may be a major factor in truss uplift problems, especially if the ceiling is installed before the moisture level of the trusses has been reduced to a reasonable level. Tests on roof trusses containing unseasoned juvenile wood have demonstrated that either upward or downward movement can occur as the wood dries, depending on whether the juvinile wood is located in the upper or lower chords.

A number of factors can influence the amount of uplift:

1. Roof slope: the lower the slope, the greater the amount of arching for the same difference in moisture content between the upper and lower chords.
2. Amount of insulation: the more insulation, the greater the difference in moisture content between the upper and lower chords.
3. Moisture content of the partition framing in winter, compared with the exterior wall framing, can also contribute to the pulling of the ceiling membrane from the partition.

The contraction of the top chord relative to the bottom chord in the winter due to colder temperatures is not enough to counteract the arching caused by moisture changes. The weight of the roof assembly and the snow load, in most cases, does not have a major impact.

There is a solution to truss uplift. One is not practical: redesign trusses to avoid the condition allowing for truss uplift, by



keeping the insulation below the bottom chord. The second is to build in a way that allows trusses to do their thing without damaging the interior finish or air barrier.

This can be achieved by eliminating ceiling fasteners within 12 inches of the partitions for 1/2" gypsum board or 16" for 5/8 gypsum board, and by joining the ceiling to the interior partitions so that the trusses can move up without breaking the joint. The ceiling membrane can be coupled to the partition by using drywall clips or corner beads nailed to the tops of the partitions so that the ceiling membrane is forced to flex, rather than tear away from the partition, as the truss moves upward.

If such "floating corners" have not been provided, damage at the partion can be masked by installing can mouldings fastened to the ceiling support only. This permits the moulding to slide up and down the wall with the seasonal movement of the trusses.

A video which provides a clear explanation of how to deal with truss uplift has been prepared by Forintek Ltd.

LETTER TO THE EDITOR

Sir,

I feel much more informed after reading the article "Indoor Air Quality" in your August-September issue.(SOLPLAN REVIEW #16)

The federal government department for which I work has recently announced a ban on smoking in the work place of which I am greatly in favour. I work in a 16 storey, air-conditioned, mechanically ventilated office building.

It has been argued that banning smoking in our office which occupies half of one floor (we have fifteen employees - four are heavy smokers) will make no significant difference in indoor air quality since we are breathing the recirculated air of the entire building anyway. Our smokers will smoke in the basement cafeteria and other offices throughout the building will continue to have smokers.

I am disheartened to believe that this argument probably does make sense. (Of course, an example needs to be set and one has to start somewhere.)

Can you please comment, or direct me to the appropriate scientific research?

Also, if you are aware of the effect of the use of photocopiers on indoor air quality I would appreciate any information.

Jan Napier, Halifax, N.S.

While a large part of the indoor air is recirculated, affecting indoor air quality, there is always 'fresh air' coming in. Ventilation systems for buildings built in recent years have been designed to provide 7 1/2 to 10 cfm of fresh air per person in the building. Recent ASHRAE recommendations are to increase this to 15 cfm per person.

What actually happens in any specific building will depend on the design of the mechanical system. Generally there will be at least 10% new air introduced.

If air from a smoke filled room is recirculated to the rest of the building, it should at least be treated with a high efficiency filter. It is preferable that designated smoking areas exhaust directly to the outside. The City of Vancouver requires that if air is recirculated, it must be treated by filtration (e.g. electrostatic) - it does not remove 100% of the smoke, but it goes a long way towards it.

Reducing areas where smoking is allowed will generally reduce the total amount of smoke in the building, as it is unlikely that heavy smokers will rush down to the cafeteria every few minutes for their nicotine fix, nor are they likely to make-up the number of cigarettes when they do go down.

Wet process copies are a major source of volatile organic compounds which can be severe pollutants. Adequate ventilation is the preferred remedial action.

ATTIC MOISTURE CONTROL NORTH OF 60°

Arctic conditions are severe and construction failures are more dramatic than elsewhere. Housing throughout the Arctic experiences severe winter frost build-up and subsequent damage to ceilings and roof insulation. In many communities it has become "normal" to replace the insulation **every year**, and to live with badly stained and damaged ceilings.

Some moisture may regularly accumulate in attics in warmer climates, but the longer and warmer summers ensure that the construction can dry out. Water stains on the attic ceilings are not always roof leakage but the result of condensation.

Problems with moisture control in attic spaces of arctic housing have been known since 'conventional' construction North of 60 started. Attempts at resolving the problem have met with varying degrees of success on an individual unit basis. There are no global solutions available to date.

A study commissioned by Canada Mortgage and Housing Corporation looked at possible retrofit solutions to attic moisture control.

The study looked at two proposed retrofit systems to eliminate or minimize attic moisture accumulation. Typical ten year old, four bedroom stick-built bungalows with asphalt shingle sloped roofs, wood truss roof framing and an uninsulated attic space in 3 communities were tested.

Three different alternatives were examined.

1. Vapour Barrier Retrofits

Existing ceiling insulation was removed and a new vapour barrier was fitted between the existing roof trusses, the insulation was replaced, and the gable vents were blocked off. A humidistat controlled stack vent was installed to control humidity in the house and modify the position of the neutral pressure plane.

In order to accurately reflect the site work and supervision which would be found in the field, no special guidance was given the contractor.

The test houses for vapour barrier retrofits were located in Yellowknife, where the climate is less severe than in other test locations.

Observations made

Tightness tests were carried out before and after construction. Improving the ceiling vapour barrier did not significantly change the air tightness of the units. The infiltration into the houses did not decrease after installation of a new ceiling vapour barrier. By thermography, it was found that most infiltration and exfiltration occured at the floor/wall and wall/ceiling joints.

The vapour barrier retrofit demanded painstaking attention to detail and above average supervision. Inspection revealed that air leakage is occurring into the attic in spite of the new vapour barrier installation, especially where the vapour barrier is discontinuous, such as where the truss chords are joined. Heaviest frost build-up was on the gable ends, with a uniform hoarfrost on the shaded side of the house.

The stack vents were complicated and expensive, produced no beneficial change to the units, and detracted from occupant's comfort. Stack vents are not recommended.

Quality of workmanship and supervision supplied for this test was better than could be expected in general construction, especially in remote communities.

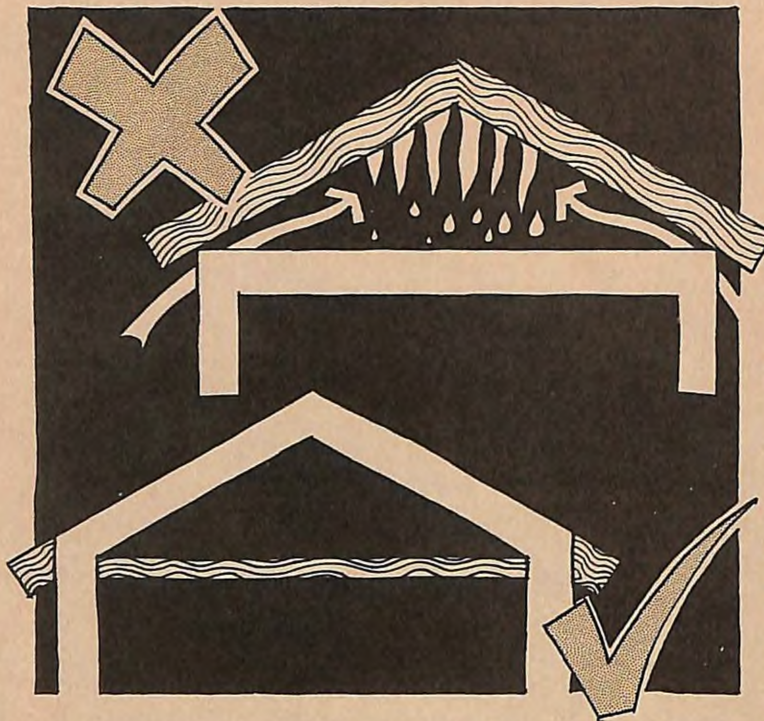
The test houses did not have moisture damage after one winter season but large areas of slightly moist insulation were noted as moisture was entering the attics.

Based on observations it is doubtful that the vapour barrier retrofit system could be used successfully on a broad scale to prevent moisture accumulation and damage in Arctic housing.

2. Metal Roof Retrofit

3 inches (75mm) of rigid foil faced insulation was added over an existing roof and gables and was covered with a new metal roof. This approach provides a warm attic space and tries to eliminate moisture build-up by moving the dew point outside the old roof shingles.

Although not part of the original design intentions, the original vapour barrier and ceiling insulation were left in place.



3. Modified Metal Roof Retrofit

Based on preliminary findings of the study, the metal roof support system was modified to 6 inch (150mm) deep sheet metal girts with batt insulation between.

To determine the relative performance of the two systems, visual inspections were made in the winter and summer and air pressure, relative humidity, temperature, and timber moisture content readings were taken occasionally.

What was found on metal roof retrofits:

There was no pressure across the original ceiling and vapour barrier. This is because the metal roof retrofit is air tight, stopping infiltration. This prevents moisture transfer by the exfiltrating moist air, as moisture is only transmitted by thermally induced air movement.

The metal roof retrofits were relatively successful in minimizing attic frost build-up with the exception of some obvious thermal bridges.

The cost of the two approaches were similar. As a bonus, the metal roof system cost includes a new long-life roof.

It is suggested that thermal bridges be minimized, that the eaves be air tight, that the roof fastener system be upgraded to prevent possible fastener withdrawal and lead to structural failure.

The metal roof retrofit is the better of the two approaches to minimizing moisture accumulation and damage in Arctic housing.

This study emphasizes the importance of the skills in the construction process. It also points out the need to follow proper construction practices, in the harsh climatic conditions of the arctic, or more moderate southern climates.

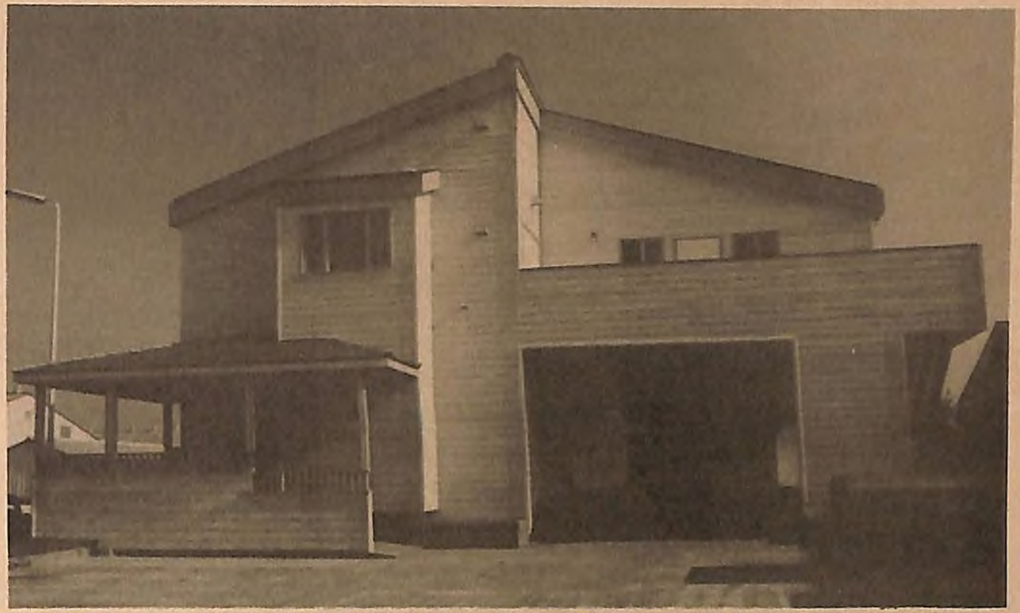
Attic Moisture Control North of 60
Investigation & Comparison of Two Potential Solutions by Ferguson, Simek, Clark Engineers and Architects for Canada Mortgage & Housing Corp.

1985 NATIONAL BUILDING CODE
CHBA Guide to the Amendments to Part 9

Members of the Canadian Homebuilders Association will shortly be receiving a copy of this excellent illustrated publication that explains and reviews changes that have been made in the 1985 edition of the National Building Code. This edition is now being implemented by most Canadian jurisdictions. Each change is rated for its significance: 1) having a minor impact on the industry; 2) a change worth studying; and 3) a significant amendment.

While each jurisdiction makes some changes and local revisions before implementing the code, the basic code is constant.

HOUSING INDUSTRY TRAINING CENTRE



The Canadian Homebuilders Association of B.C. opened its new Housing Industry Training Centre on Sept. 25, 1987. Located on the campus of the B.C. Institute of Technology in Burnaby, it will be the association's Education and Training Centre for B.C., and will house CHBA-BC offices.

The 5000 square foot 2 storey building has been designed to demonstrate wood frame techniques and technologies used in R-2000 construction. It incorporates 2 wall systems, preserved wood foundation, and separate mechanical systems for each floor. Portions of the building construction have been left exposed on the interior and exterior of the building, like a permanent cut-away section to show the construction methods used. As well the building mechanical room is glazed, providing a permanent display.

The main floor contains a large seminar room plus two smaller meeting rooms which will be used for R-2000 and other industry seminars. The second floor will have CHBA-BC offices and technical library.

Construction was timed to coincide with the 4th International Housing and Home Warranty Conference (Sept. 27-Oct. 1, 1987 in Vancouver). It was financed by cash and material donations from the housing industry. Design, construction and regulatory approvals were completed in the record time of 11 weeks!

The building opened with an exhibit of R-2000 construction techniques. These are set up like a walk-in catalogue of techniques and systems used in R-2000 housing. It is open to the public as part of a major R-2000 promotion until early December 1987.

This table lists the latest performance data for heat recovery ventilators that have been tested by the Ontario Research Foundation. The information provided is the data required to model the HRV in the HOT-2000 computer program.

The **net supply airflow (75 Pa)** gives us an idea of how much air the unit could supply in a typical installation (at 75 pascals/.4"W.G. pressure).

The **net airflow** at a given test temperature is the operating condition under which the efficiency has been obtained. Higher airflows generally reduce, while lower flows increase the unit efficiency.

Average power is the power consumption of the unit at that condition.

HRV EFFICIENCY RATINGS

MODEL	NET SUPPLY AIRFLOW (75 PA)	AT 0°C (32°F) NET AIRFLOW	AVERAGE POWER	EFFICIENCY	AT -25°C (-13°F) NET AIRFLOW	AVERAGE POWER	EFFICIENCY
AIRXCHANGE 502CA	142 CFM	112 CFM	104 W	77%	97 CFM	978* W	44%
AIRCHANGER DRA-150	104	57	72	82%	121	72	57%
AIRCHANGER DRA-275	231	129	126	76%	170	216	50%
CAN RAY 2000EX-H	136	61	120	54%	129	154	49%
EZ-VENT 320	180	129	138	67%	119	110	70%
LIFEBREATH 200 MAX	193	119	100	60%	127	100	59%
LIFEBREATH 300	235 **	119	150	79%	125	156	75%
NUTONE *** AE-200	159	123	118	68%			
STAR 300 MPC-DV	186	117	128	79%	117	138	67%
THERMAIR 2000 RD	199	125	155	57%	129	213	54%
VANEE 2000/2D	237	133	100	62%	121	87	58%
VANEE 2000/2DM	216	127	116	69%	117	120	60%

* *This unit uses an electric preheater*
** *This is flow at 100 Pa*
*** *Low temperature efficiency rating not calculated as the unit is not able to provide 110 cfm at -25°C.*

LEBCO COMMENTARY

The proposed free trade agreement between Canada and the USA raises questions about the future of the Canadian economy. If implemented, the home building industry will have to come to terms with the results of such an agreement as all activity in Canada will be affected.

Free trade will alter the way we do business and the products we use. It may force the standardization of Codes and Standards in the two countries for fear that codes and standards may be considered a barrier to trade. (Even though the USA has no national Building Code, and many local codes are written to protect local products).

Not enough information has been provided yet to consider the effects. However, the housing industry must assess the significance of such changes to the economy **before** they are introduced, in order to either suggest modifications or to be prepared for changes.

Will the agreement affect products and their availability? Will it mean some familiar products will disappear? Will it mean shortages of products as manufacturers aim to serve an export market? Will we be swamped with new exotic products of unknown quality or suitability?

What will be the impact on the housing industry if there is freedom of movement for industry and professionals? It may mean that it will be easier to get skilled trades people into a given area when it experiences boom times. It may mean that Canadian contractors have to face new competition from larger corporations with greater financial resources. It may also mean we will have free trade among the provinces inside Canada!

The overall impact of the proposed agreement on the Canadian economy in general must be considered. If the economy benefits from increased economic activity generated by free trade, it will mean everyone will be better off financially. It should mean a better housing market for all - from suppliers to contractors and all others involved with housing.

On the other hand, if there are negative effects on the Canadian economy (as is quite likely at least during a transitional period over the first few years) then the results could be exactly the opposite, and we could see a repeat of the depressed housing market that we suffered through recently.

To estimate the prospects for success of the deal, the character of our two nations must be kept in mind. Canadians **are** different from Americans. Our economy has developed differently. An important portion of Canadian business activity is carried out by public agencies or in partnership with the government. Our approach is to consider programs for their benefit to the community, while Americans value individual action above community goals.

We have established a range of programs, be they direct assistance, protective tariffs, or indirect funding of marketing and research programs for industry. As well, there has been a reliance for basic research work to be done or funded by public agencies rather than individuals and corporations.

Another important difference is the network of social programs we have developed, from education to medical programs that make this country so liveable. Whether we agree or not with the way many of the programs are managed or targeted, they define the country and make Canada what it is. In most cases, there were important reasons why the programs were developed in the first place, not least being the small, spread-out population of the country.

Either way, whether or not free trade is adopted, there is a price to be paid. The impact free trade will have on our social and political system is unknown at this time. However, it should be reviewed carefully before irreversible decisions are made, for they will affect us all.

Proponents for free trade are suggesting that a leap of faith be taken, and that all will work out well. But how often do you sign a blank cheque and give it away?

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